

FIG. 1

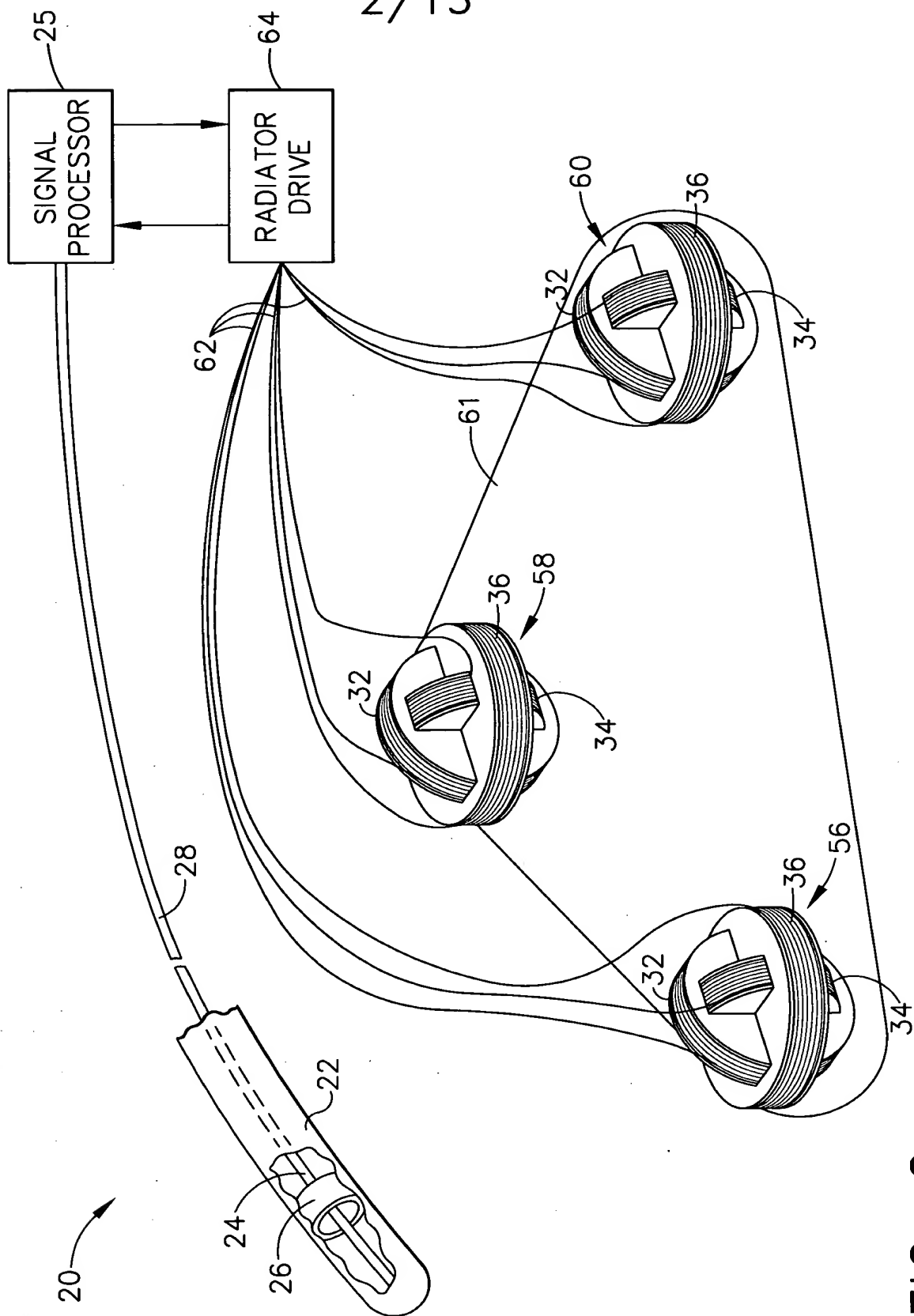


FIG. 2

```

graph TD
    70[INITIAL START POINT  
OF SENSOR POSITION  
AND ORIENTATION] --> 72[REFINE INITIAL POINT  
BASED ON DIPOLE  
APPROXIMATION  
(OPTIONAL)]
    72 --> 74[74  
CALCULATE  
MAGNETIC FIELD AT  
ESTIMATED SENSOR  
POSITION AND  
ORIENTATION]
    74 --> 76[76  
CALCULATE  
STEEPEST DESCENT  
(CALCULATED FIELD  
TO MEASURED FIELD)]
    76 --> 78[78  
CALCULATE  
NEW ESTIMATE FOR  
POSITION AND  
ORIENTATION]
    78 --> 78a[78a  
CALIBRATE]
    78a --> 74
    78 --> 74b{74b  
IS  
NEW  
ESTIMATE  
WITHIN DESIRED  
RANGE  
?}
    74b -- NO --> 74
    74b -- YES --> 74c([74c  
POSITION  
DETERMINED])
  
```

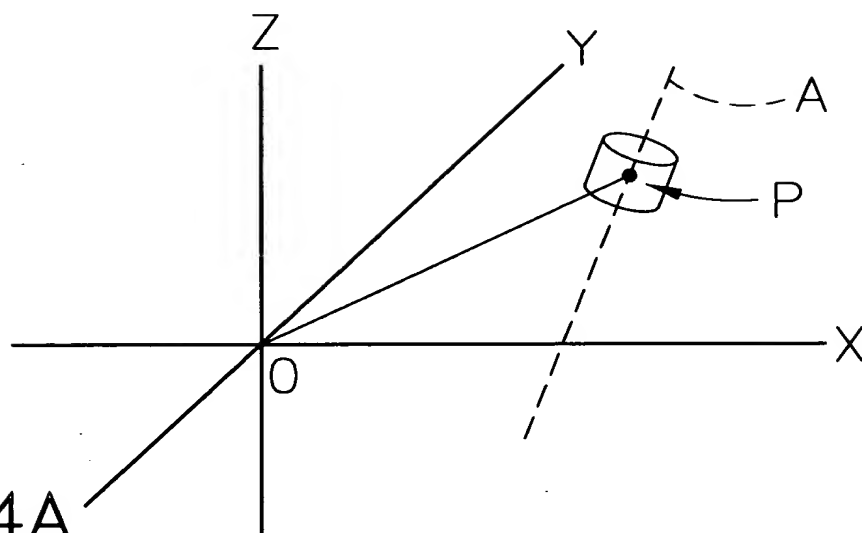


FIG. 4A

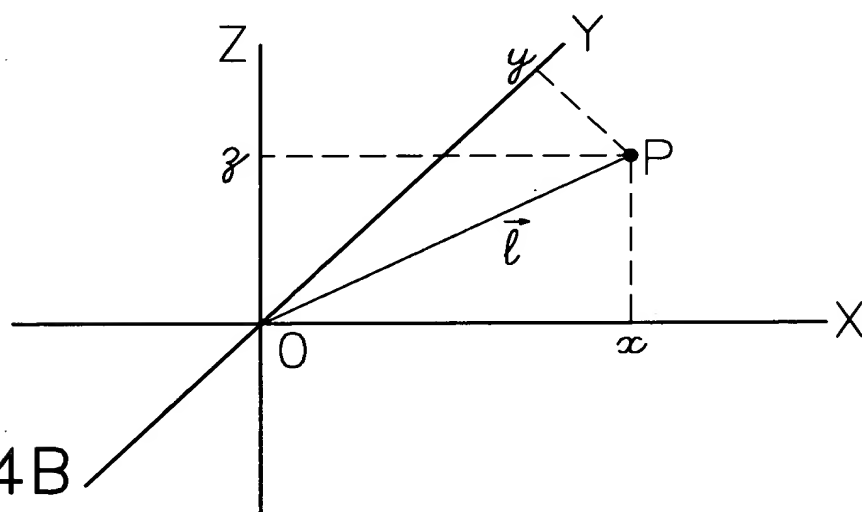


FIG. 4B

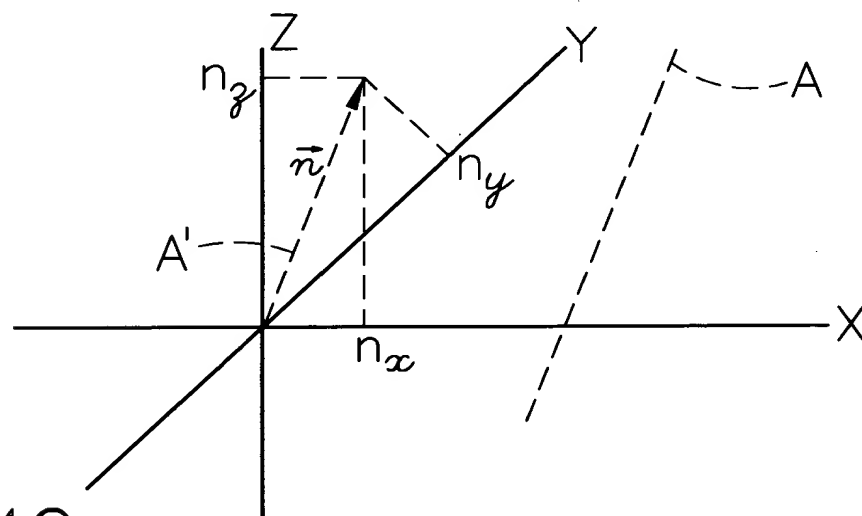


FIG. 4C

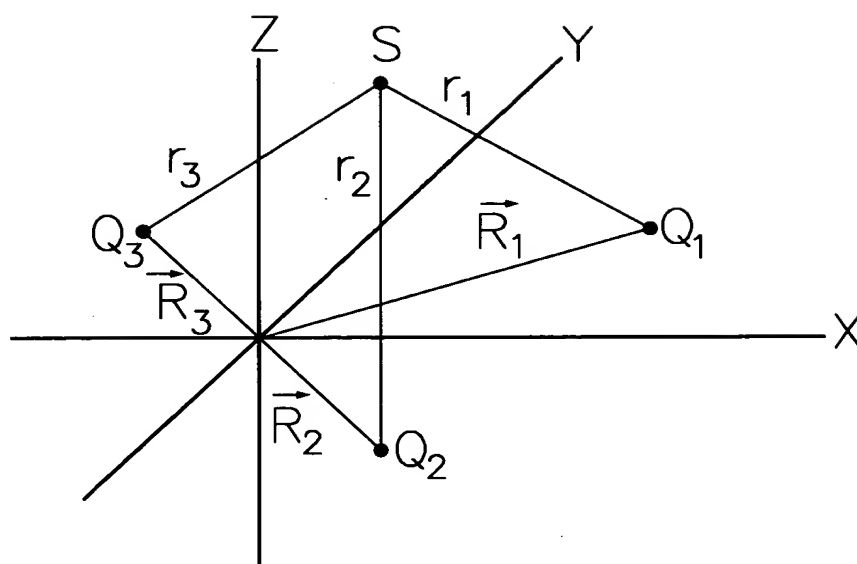


FIG. 4D

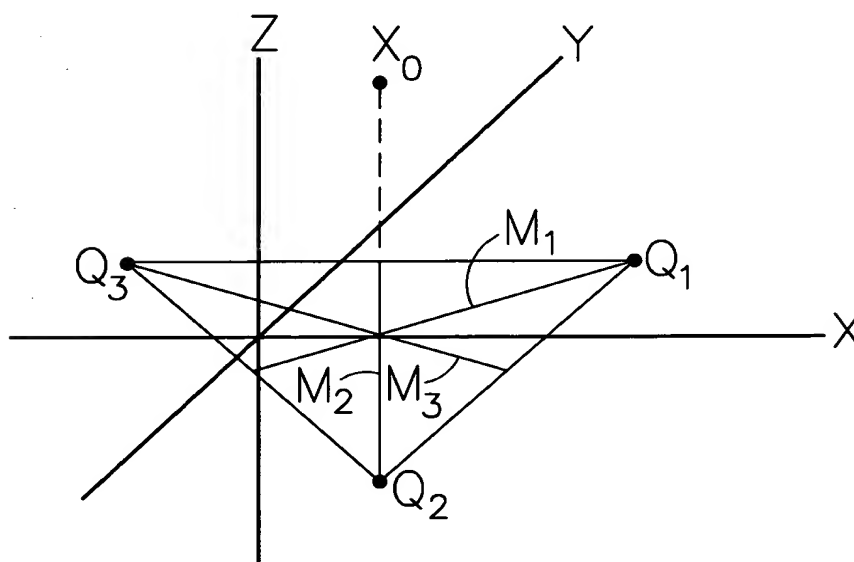


FIG. 4E

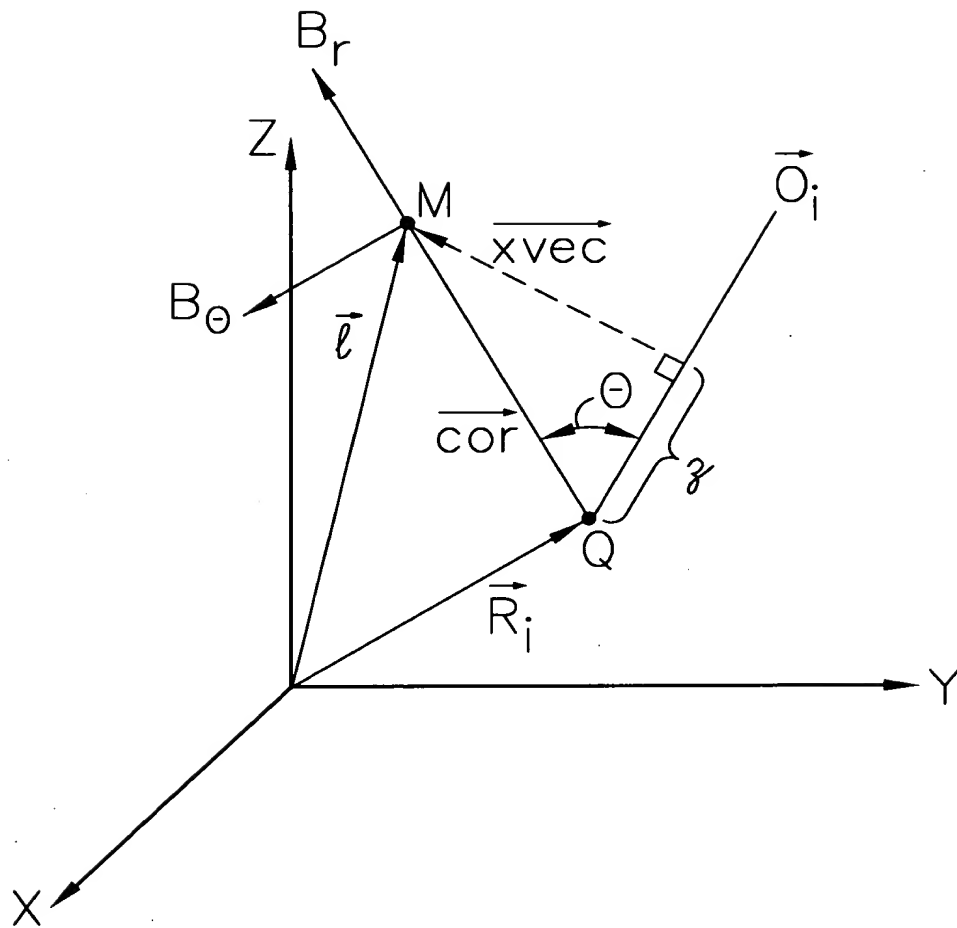


FIG. 4F



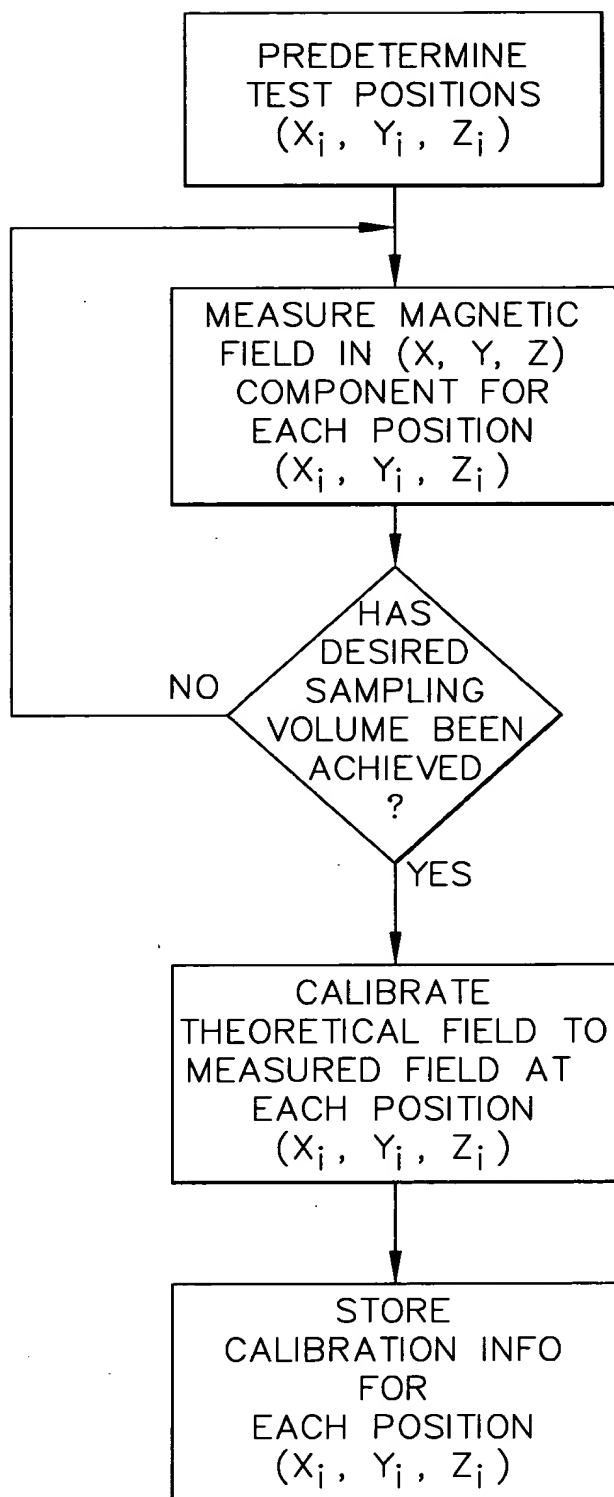


FIG. 6

000270 22E12960

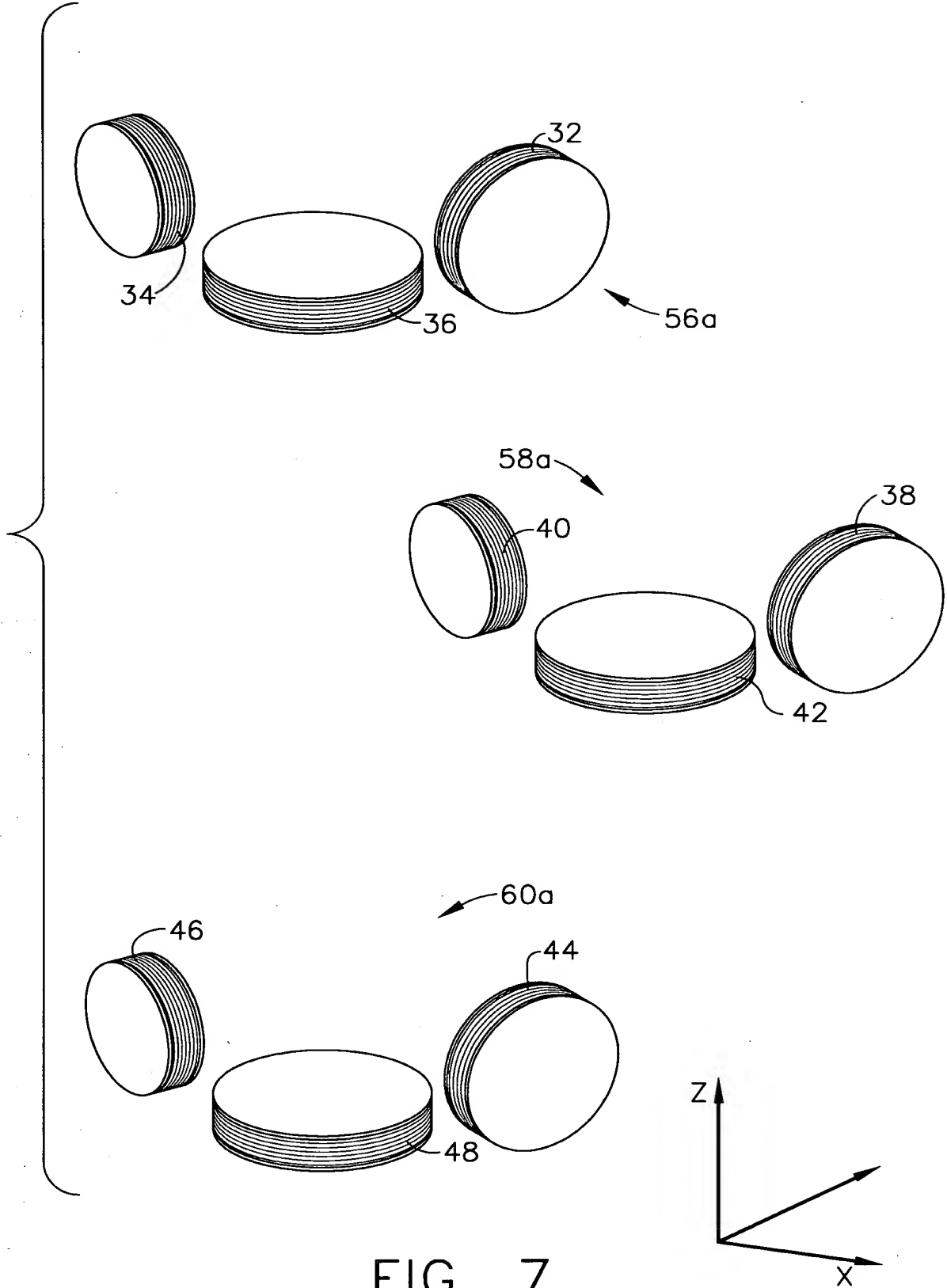


FIG. 7

000240" 222T2960

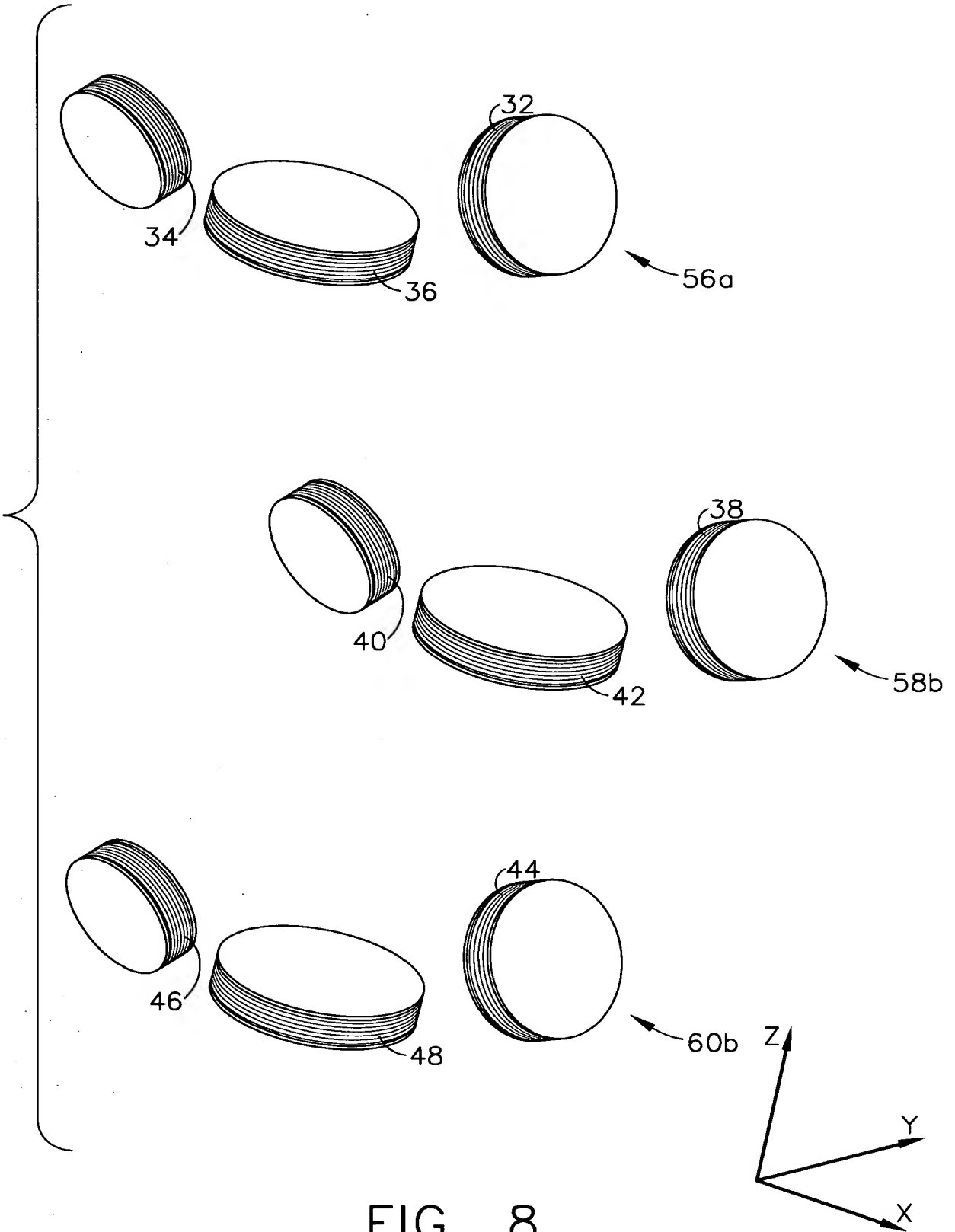


FIG. 8

000220 22ET2950

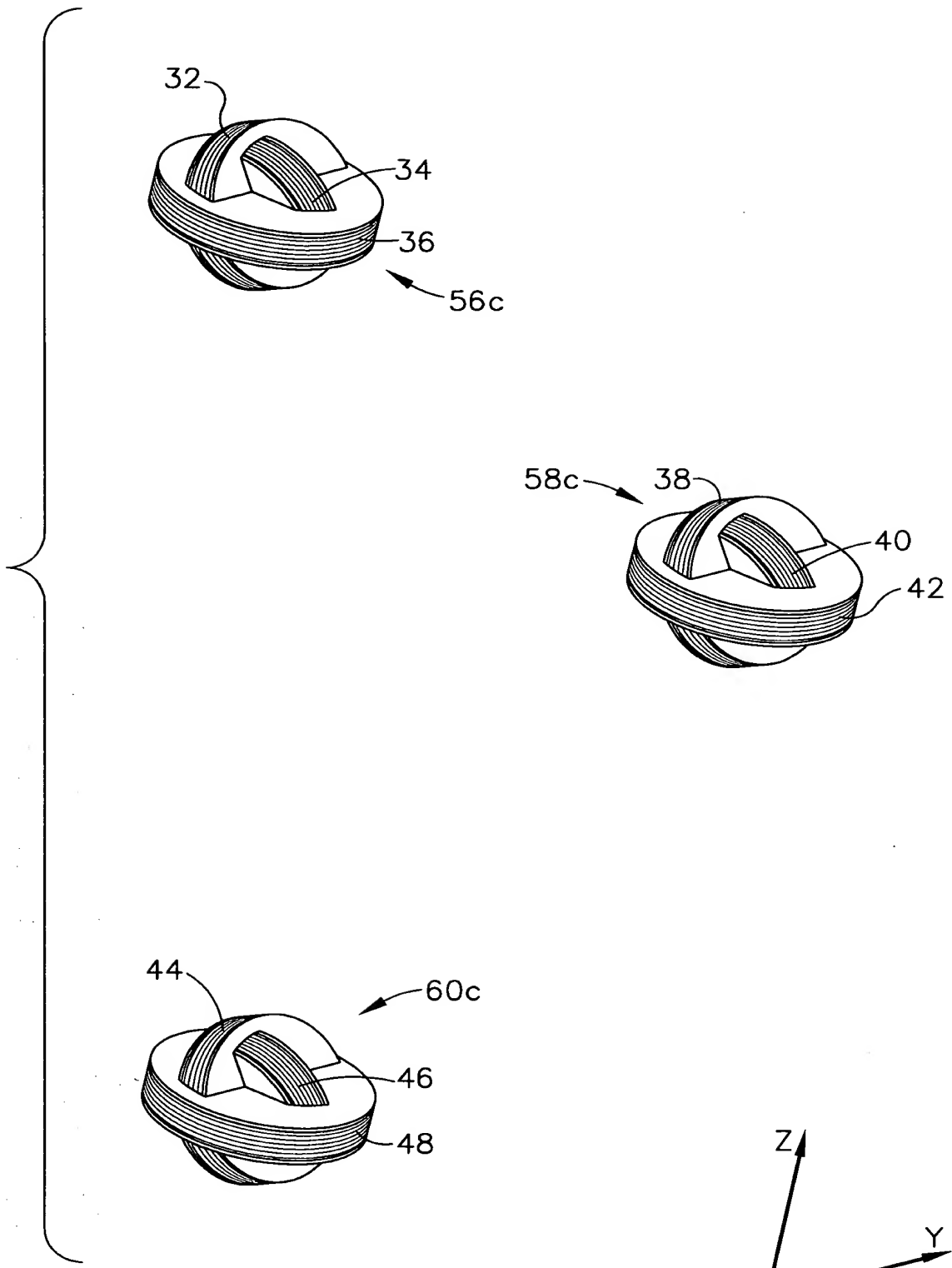


FIG. 9



000220" 22ET2960

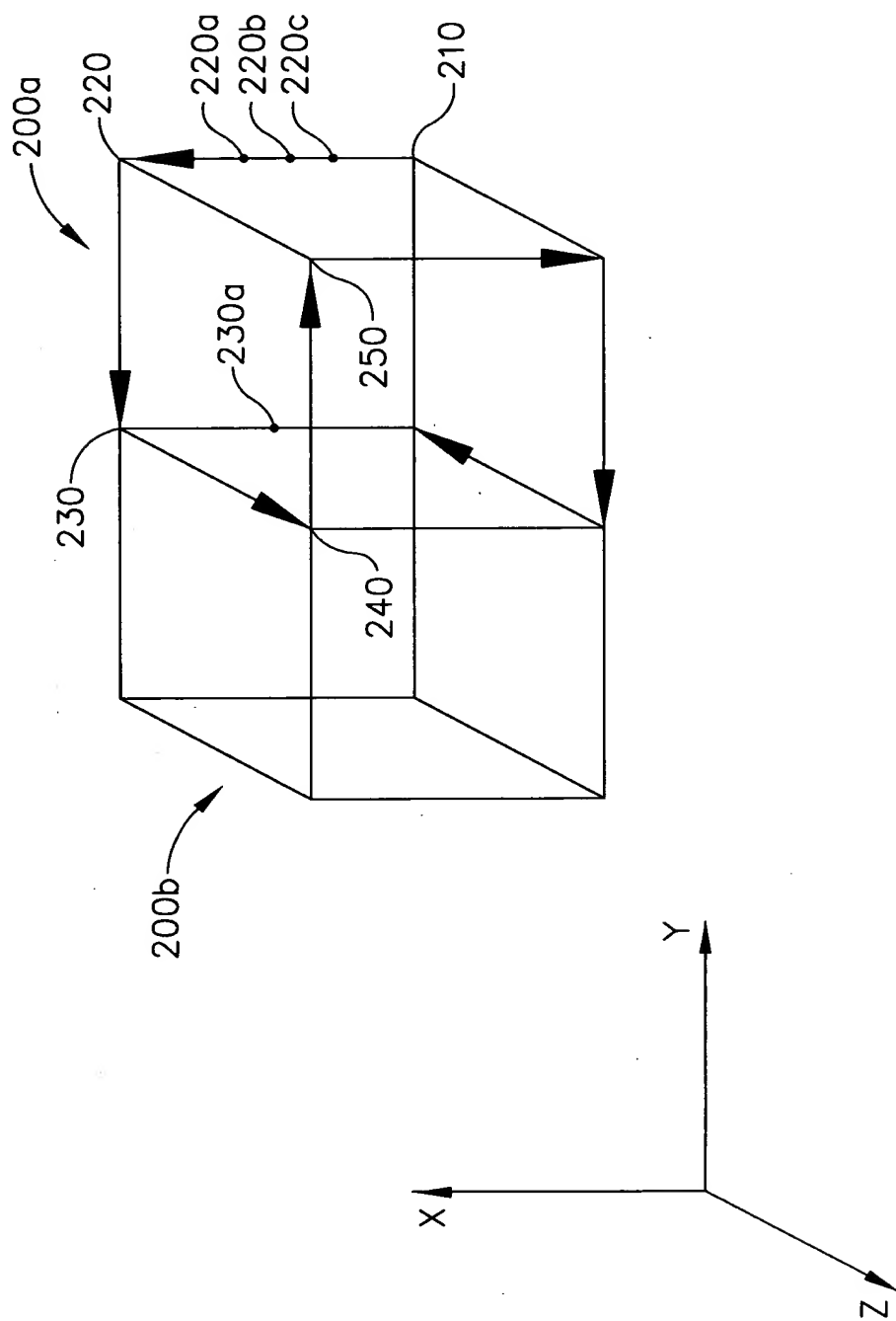


FIG. 11

PLACE STATIC METAL IN MAPPING VOLUME

14/15

ALIGN SENSOR AT FIRST POINT
(X_i, Y_i, Z_i)

READ MAGNETIC FIELD AT POINT
(X_i, Y_i, Z_i)

USE SAME
COORDINATE
AXIS

STEP SENSOR TO
NEXT POINT
(VERTEX)
($X_i + dx, Y_i + dy, Z_i + dz$)

SELECT
ANOTHER
COORDINATE
AXIS

READ MAGNETIC
FIELD AT NEXT
POINT
($X_i + dx, Y_i + dy, Z_i + dz$)

SET
 dx, dy, dz
AS
 $dx = dx/2$
 $dy = dy/2$
 $dz = dz/2$

INTERPOLATE MAGNETIC
FIELD AT AN
INTERMEDIATE POINT
AND CALCULATE POSITION

SET
 X_i, Y_i, Z_i
AS
 $X_i = X_i + dx$
 $Y_i = Y_i + dy$
 $Z_i = Z_i + dz$

DETERMINE DIFFERENCE IN CALCULATED
INTERMEDIATE POSITION AND ACTUAL
INTERMEDIATE POSITION

IS
POSITION
DIFFERENCE WITHIN
ERROR
LIMIT
?

NO

YES

FIG. 12

000220" 22222950

PLACE STATIC METAL IN MAPPING VOLUME

15/15

ALIGN SENSOR AT FIRST POINT
(X_i, Y_i, Z_i)

READ MAGNETIC FIELD AT POINT
(X_i, Y_i, Z_i)

EXTRAPOLATE MAGNETIC
FIELD AT A NEXT POINT
(VERTEX)
($X_i + dx, Y_i + dy, Z_i + dz$)

CALCULATE POSITION
AT EXTRAPOLATED
POINT
($X_i + dx, Y_i + dy, Z_i + dz$)

DETERMINE DIFFERENCE
IN CALCULATED POSITION
AND ACTUAL POSITION
(OF EXTRAPOLATED POINT)

IS
POSITION
DIFFERENCE WITHIN
ERROR
LIMIT
?

USE SAME
COORDINATE
AXIS

SET
 $dx = dx/2$
 $dy = dy/2$
 $dz = dz/2$

SET
 dx, dy, dz
ACCORDING
TO STEP
DISTANCE
REQUIREMENT
AND STEP
SENSOR TO
NEW POINT
ALONG
ANOTHER
COORDINATE
AXIS

FIG. 13

000240" 22257960